Finding Containment, Remediation and Site Characterization Solutions in Fractured Rock - The Smithville Strategy

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Background

In 1978 a company located in Smithville, Ontario, Canada (near Niagara Falls) known as Chemical Waste Management Limited (CWML) was granted a Certificate of Approval by the Ontario Ministry of the Environment to operate a hazardous waste transfer station. The company received 434,000 litres of liquid waste between 1978 and 1985. More than half of the waste is estimated to have been polychlorinated biphenyl (PCB) wastes.

CWML had planned to ship the collected wastes to a hazardous waste facility in the United States but this option was lost when the Canada-United States border was closed to hazardous waste shipments in 1980. Subsequently, the CWML site inventory filled to capacity in 1983. In 1985, the site became the focus of intense attention from the public and news media when a group of local environmentalists discovered PCB oil in a shallow stormwater lagoon on the site. The Ontario Ministry of the Environment immediately took control of the site and initiated a remediation program organized in four phases.

Phase I involved immediate actions to secure the site and was completed at the end of 1985. Phase II, which was completed by March 1987, consisted of the construction of safe storage facilities and transfer of on-site contaminants into safe storage. In February 1987, PCB oil was discovered to have escaped into the groundwater and fractured bedrock beneath the site. A dissolved phase plume containing PCBs, tricholorbenzene (TCB) and trichloroethylene (TCE) was found extending south from the CWML site threatening the municipal well supplying potable water to the town. The well was shut down. The Ministry funded construction of a water pipeline to provide a secure potable water source for the town. Subsequent investigations concluded that there was approximately 10,000-30,000 litres of PCB-bearing DNAPLs (dense non-aqueous phase liquids) located in the upper portion of the bedrock beneath and adjacent to the former CWML site. By 1989, a pump and treat system was implemented to prevent off-site migration of the dissolved phase contaminant plume. Phase III was the destruction of the on-site inventory of PCB using a mobile rotary kiln incinerator and was completed in 1993. By the end of the first three phases of the clean up the surface of the site had been restored; however, contamination remained in the fractured rock beneath and adjacent to the site.

An Innovative Management Strategy

In late 1993, the municipality and the Ontario Government signed an agreement to undertake Phase IV of the remediation program. This innovative agreement established the Phase IV Board consisting of representatives from each of the main stakeholder

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groups in the remediation program - the Ontario Ministry of Environment, the municipality and a public liaison committee. The agreement recognized that technologies for characterizing and remediating DNAPL-contaminated fractured rock sites were very limited at that time and so the need to establish partnerships, joint venture agreements and collaborative efforts to develop and evaluate potential solutions was recognized. Funding for the Board is provided by the Ontario Ministry of the Environment.

To accomplish its goals the Board first established and consulted a network of international expert advisors. Plans were then developed and implemented to undertake site characterization, engineering, modelling and risk assessment work at the site under the framework of a 10-step decision-making process established to identify and evaluate potential remedial technologies for the Smithville PCB spill site.

Achievements

In 1994, the newly formed Board achieved an early and very significant milestone when it secured a collaborative research agreement with the U.S. Environmental Protection Agency (EPA), Environment Canada, the University of Waterloo and other universities to assist with site characterization and modelling of the Smithville fractured rock site. Between 1995 and 1999, the Smithville site underwent extensive site characterization work including numerous hydraulic tests, tracer tests, bedrock properties studies and DNAPL physical and chemical characterization. As a result of this leading edge work Smithville is now regarded as one of the best characterized DNAPL-contaminated fractured rock sites anywhere.

In 1998, further agreements were forged with the EPA, U.S. Department of Energy (DOE), QUEEN'S University and the Ontario Ministry of the Environment to collaborate and share information on site characterization and remediation techniques applicable to contaminated fractured rock sites. These agreements brought additional expertise and resources to the Smithville program resulting in increased confidence in the program findings and decision-making process. In addition, the Smithville management team has contributed to the DOE's Innovative Treatment Remediation Demonstration program to select a remediation technology for DNAPL at the DOE's Y-12 plant in Oak Ridge, TN.

A recent, significant success of the agreements between the Phase IV Board, the Ontario Ministry of the Environment, the Environmental Protection Agency and the Department of Energy was the successful completion of the ***Fractured Rock 2001*** conference held in Toronto in March 2001. This specialized conference, attended by experts from 17 countries including Canada and the United States, demonstrated that the newly formed partnerships were working and producing useful results.

The Board is approaching the conclusion of its decision-making process and is expected to submit its recommendation report to the Ontario Minister of the Environment later this year. The Minister will consider the Board's recommendation and findings when developing a plan for the future management of the site.

Lessons Learned
The management approach used at Smithville site has been very successful. Other site owners and regulators faced with remediation at similar sites should find the Smithville experience informative and useful. Following are the main lessons learned at Smithville:

1. The management strategy to place stakeholders of the clean-up on the managing Board responsible for overseeing the remediation program greatly increases trust among the stakeholders and the public, provides for an open method of conducting business, reduces costs by avoiding duplication of work and enhances the likelihood that the recommended remedial actions will be acceptable to stakeholders.

2. A clear, traceable and transparent decision-making process with ample opportunity for public review and comment is essential.

3. Partnerships and collaborative agreements contribute significantly towards the cost-effective development and evaluation of potential solutions. They increase credibility and enhance technical knowledge while reducing cost.

4. Regular liaison with a network of technical experts, colleagues and practitioners is absolutely essential in order to remain abreast with the rapidly advancing technical field of fractured rock characterization and remediation.

5. Effective solutions are best developed by using a team from academia, government, consulting and private industry. Managing the team can be challenging.

Future Opportunities
There is tremendous opportunity to continue and enhance the current collaborative efforts between the Smithville Remediation Program, the Ontario Ministry of the Environment, Environmental Protection Agency and Department of Energy. These initial agreements have been very successful thus far and could be expanded both in terms of areas of cooperation and partners. Continued partnerships and collaboration will benefit all parties.

One proposal suggested by O'Neill et al. (2001) involves development of strategies to estimate the extent and magnitude of the contamination problem in fractured rock sites in North America. An understanding of the extent of this problem is essential for those addressing contaminated sites and to planners in industry and government responsible for prioritizing research and development budgets for characterizing and remediating fractured rock sites. The authors propose two strategies for improving the current knowledge base. The first is development of a comprehensive database for contaminated fractured rock sites. The second is a screening process using map overlays to identify and map key factors such as geology, tectonic setting, depth of soil, proximity to surface water bodies, etc., known to be linked to a high risk of bedrock contamination.

Assuming that these initiatives could be implemented, a possible future initiative would be to establish a set of testing locations for developing and evaluating characterization and remediation technologies in representative fractured rock settings. Representative areas might be as large as physiographic provinces.

References

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